CLAIMS:

1. A microwave antenna for medical ablation, comprising: a transmission line having an inner conductor, an outer conductor and a dielectric insulator to provide insulation between the inner and outer conductor, and an energy emitting antenna element positioned at the distal end of the transmission line to transmit a microwave near-field; wherein the antenna element has an inner conductor electrically coupled to the inner conductor of the transmission line, and a sheath of dielectric insulator around the inner conductor; and wherein a conducting cap is electrically connected to the distal end of the inner conductor, and the cap surrounds a length of the sheath of insulator, and the dimensions of the cap are determined to provide impedance matching between the antenna element and the transmission line.

2. An antenna according to claim 1, wherein the particular dimensions of the metallic cap that are determined include one or more of:

the length of the cap;

the length of the sheath of insulator that is surrounded by the cap; and

the radius of the cap.

3. An antenna according to claim 1 or 2, wherein the antenna element is built into the end of the transmission line, and the cap is fixed to the inner conductor of the transmission line.

4. An antenna according to claim 3, wherein a first length of the outer conductor is removed from the distal end of the transmission line to create the antenna element.

5. An antenna according to claim 4, wherein a shorter length of the dielectric insulator is removed from the distal end to expose a length of the inner conductor for fixing of the cap.

6. An antenna according to claim 5, wherein the dimensions to be determined further include:

the length of exposed inner conductor between the distal end of the sheath of insulator and the cap.

7. An antenna according to any preceding claim, wherein the antenna element is configured with conducting rings spaced apart from each other along its length by slots.

8. An antenna according to claim 7, wherein the antenna element comprises insulating and conducting rings placed alternately along the length of insulating sheath.

9. An antenna according to claim 8, wherein one or more of the following dimensions are determined:

the width(s) of the conducting rings;

the width(s) of the slots; and

the length of the antenna element between the end of the outer conductor and the cap.

10. An antenna according to claim 7, 8 or 9, wherein the conducting rings comprise rings of outer conductor.

11. An antenna according to claims 7, 8 or 9, wherein the cap is made using a conducting ring.

12. An antenna according to any one of claims 7 to 11, wherein the sizes of the conducting rings and the slots between them are selected to determine the shape of the near-field distribution.

13. An antenna according to claim 12, wherein all the conducting rings are the same size, and all the slots between them are the same size.

14. An antenna according to claim 13, wherein the conductive rings are twice as wide as the slots between them.

15. An antenna according to claim 12, wherein the slot and ring sizes gradually increase towards the tip of the antenna makes a forward firing antenna.

16. An antenna according to claim 12, wherein the slot and ring sizes gradually decrease towards the tip of the antenna makes a reverse firing antenna.

17. An antenna according any preceding claim, wherein the dielectric loading produced by the size of the insulator surrounded by the cap is determined to ensure the near field flow terminates at the tip of the antenna rather than at the transmission line/antenna element junction.

18. An antenna according to any one of claims 1 to 6, wherein the antenna element is configured by being bent to form an open loop oriented such that it extends transverse to the longitudinal axis of the transmission line.

19. An antenna according to claim 18, wherein one or more of the following dimensions are determined by an iterative procedure:

the straight length of the sheath of insulator before bending begins;

the radius of bending between the transmission line and the open loop;

the perpendicular distance between the open loop and the beginning of bending;

the radius of the open loop;

the length the cap not surrounding the sheath of insulator; and

the perpendicular distance between the top of the cap and the transmission line.

20. An antenna according to any preceding claim, wherein the antenna comprises a Teflon sheath surrounding at least the antenna element.

21. An antenna according to any preceding claim, wherein the antenna element is delivered to an ablation site by feeding the transmission line through a catheter.

22. An antenna according to any preceding claim, wherein the antenna further comprises a temperature sensor to sense the temperature of the tissue being ablated by the antenna.

23. An antenna according to claim 22, wherein the microwave generator delivers energy at 2.45 GHz.

24. An antenna according to any preceding claim, further comprising a computer control system to monitor the ablation process and control the microwave generator.

25. A method for making a microwave antenna for medical ablation, comprising an energy emitting antenna element having an inner conductor and a surrounding sheath of insulation, in use, located at the end of a transmission line; wherein the method comprises the steps of:

forming a conductive cap at the distal end of the antenna element such that it surrounds a length of the sheath of insulator;

electrically coupling the conducting cap to the inner conductor of the antenna element; and

determining the dimensions of the cap to provide impedance matching between the antenna element and the transmission line.

26. A method according to claim 25, wherein the step of determining the dimensions of the cap includes the steps of:

determining the length of the cap;

determining the length of the sheath of insulator that is surrounded by the cap; and

determining the radius of the cap..

27. A method according to claim 26 or 27, wherein the antenna element is built into the end of the transmission line, and the cap is fixed to an inner conductor of the transmission line.

28. A method according to claim 27, wherein a first length of the outer conductor of the transmission line is removed from the distal end of the transmission line to create the antenna element.

29. A method according to claim 28, wherein a shorter length of the dielectric insulator of the transmission line is removed from the distal end to expose a length of the inner conductor for fixing of the cap.

30. A method according to claim 29, comprising the step of:

determining the length of exposed inner conductor between the distal end of the sheath of insulator and the cap before the step of determining the dimensions of the cap.

31. A method according to any one of claims 25 to 30, comprising the further step of configuring the antenna element with conducting rings spaced apart from each other along its length by slots.

32. A method according to claim 31, comprising the step of spacing the conducting rings apart from each other by insulating rings.

33. A method according to claim 32, comprising the following steps before the step of determining the dimensions of the cap:

determining the width(s) of the conducting rings;

determining the width(s) of the slots; and

determining the length of the antenna element between the end of the outer conductor and the cap.

34. A method according to claim 31, 32 or 33, wherein the conducting rings comprise rings of the outer conductor of the transmission line.

35. A method according to claims 31, 32 or 33, wherein the cap is made using a conducting ring.

36. A method according to any one of claims 31 to 35, comprising the step of selecting the sizes of the conducting rings and the slots between to determine the shape of the near-field distribution.

37. A method according to claim 36, wherein all the conducting rings are the same size, and all the slots between them are the same size.

38. A method according to claim 37, wherein the conductive rings are twice as wide as the slots between them.

39. A method according to claim 36, wherein the slot and ring sizes gradually increase towards the tip of the antenna to make a forward firing antenna.

40. A method according to claim 36, wherein the slot and ring sizes gradually decrease towards the tip of the antenna to make a reverse firing antenna.

41. A method according any one of claims 25 to 40, comprising the step of determining the dielectric loading produced by the size of the insulator surrounded by the cap to ensure the near field flow ends at the tip of the antenna rather than at the transmission line/antenna element junction.

42. A method according to any one of claims 25 to 30, comprising the further step of configuring the antenna element by bending it to form an open loop oriented such that it extends transverse to the longitudinal axis of the transmission line.

43. A method according to claim 41, comprising the further step of determining one or more of the following dimensions before the step of determining the dimensions of the cap:

determining the straight length of the sheath of insulator before bending begins;

determining the radius of bending between the transmission line and the open loop;

determining the perpendicular distance between the open loop and the beginning of bending;

determining the radius of the open loop; and

determining the perpendicular distance between the top of the cap and the transmission line.

44. A method according to any one of claims 25 to 43, comprising the further step of encapsulating the antenna element inside a Teflon sheath.

45. A method of controlling the depth to width ratio of a lesion produced in tissue by the antenna of a microwave ablation device, including the steps of:

a) supplying microwave energy to the antenna;

b) measuring the temperature of the tissue adjacent to the antenna;

c) ceasing the supply of microwave energy to the antenna when the measured temperature reaches a first predetermined temperature; and

c) recommencing the supply of the microwave energy to the antenna when the measured temperature falls to a second predetermined temperature.